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Report of the

Jefferson Laboratory
Program Advisory Committee

PAC 26

Meeting of July 12 – 16, 2004

August 16, 2004

Members of the Jefferson Lab User Group,

Since the last Program Advisory Committee meeting, a number of events have underscored the importance and quality of our scientific program. Jefferson Lab was visited by Deputy Secretary Kyle McSlarrow to announce the approval of mission need for the 12 GeV Upgrade by the Department of Energy, a critical and necessary step toward the Upgrade project. During his visit he recognized the excellence of Jefferson Lab and its programs stating "You have every reason to be extremely proud of what has been built here…and the people who work here, as innovators and leaders in fundamental nuclear physics research without parallel." We have also had a successful Onsite with Dr. Ray Orbach and a Science and Technology peer review, where the lab received positive feedback on our current science program and our plans for the future. These recent comments validate our work and the work of our users to ensure a world-class experimental program now and into the future.

The Program Advisory Committee plays a critical role in continuing to set the bar high for experiments at Jefferson Lab. PAC 26 had 16 proposals and 4 Letters of Intent to review. It has done an excellent job with 8 approved, 1 conditionally approved, 4 deferred, and 3 deferred with regret. Our users continue to bring exciting and compelling science forward for consideration, and the PAC has a very tough job in assessing these proposals.

I would like to take this opportunity to thank the members of the PAC for their thoughtful consideration on behalf of Jefferson Lab and its User Community. They provide an invaluable service to the Lab and to the User community through their considered deliberation and judgment. I look forward to continuing to work with the PAC and its members to ensure that the best and most promising science drives our program at Jefferson Lab.

Sincerely,

Christoph W. Leemann

Letter from the PAC Chairman

Introduction

The Jefferson Laboratory Program Advisory Committee held its 26th meeting on July 12 - 15, 2004. The membership of the Committee is given in Appendix A. In response to the charge (Appendix B) from the JLab Director, Dr. Christoph Leemann, the Committee reviewed and made recommendations for proposals and letters of intent submitted by JLab users.

General Overview

The PAC 26 meeting was very stimulating, particularly in view of discussions of new experiments proposed for the physics research program as well as in view of the presentation of new results of the ongoing program. The DOE decision to go ahead with the 12 GeV upgrade provided an additional pleasure of anticipation for the discussions in the PAC. New experimental data that are emerging from recent JLab measurements widen the basis for more extensive theoretical investigations. The overall JLab program continues to show solid growth; prior to PAC 26 it included 149 approved experiments. To date, 103 experiments have been completed at JLab, up by 5 over the last six months. 110 papers have been published or submitted to the Physical Review, Physical Review Letters and Physics Letters over the past year, in addition to over 259 papers published elsewhere. Archival papers dealing with the construction of the experimental facilities in the three halls have been published. The number of Ph.D. projects completed to date at JLab is 178 (up by 14 in the past six months), with an additional 168 projects in progress.

Turning to accelerator operations, in the first-half year of FY04 there were 12.4 weeks of operation with beam availability of 70 %. Hall availability averaged 86.7% and the multiplicity (the average number of halls scheduled to take data) was 2.47. The expectation of beam delivered to experiments on an annual basis is 27 weeks. The Lab management mastered in a highly praiseworthy way the implementation of the unusual recommendations of PAC 25 concerning the pentaquark program. Out of the three highest priority recommended proposals, two are finished and the third one is starting in the next few months. The preliminary schedule of beam time allocations through the end of FY05 is filled with experiments covering exciting physics questions.

The physics scope of the proposals presented at PAC 26 was very broad. They included five main themes.

The G0 collaboration intends to continue its program by running the experiment at backward electron scattering angles on both ^{1,2}H which permits two different parity violating asymmetries to be extracted. These two observables can then be decomposed into vector magnetic contributions (including potential effects from G_M (strange)) and axial-vector contributions (including effects from the anapole moment). The PAC is convinced that the anticipated results of that program will provide important insight into the nature of hadronic structure in the regime of non-perturbative QCD. Due to the large momentum acceptance of the G0 detector the axial vector transition formfactor, $G^A_{N\Delta}$, can be extracted concurrently. The proposed measurements would represent the first determination of this quantity in the neutral current sector of the weak interaction.

In two other proposals collaborations address a significant extension of the Q^2-range for the electric form factor of the proton as well as for the neutron. Those data would provide stringent constraints on nucleon models and challenge anticipated rigorous lattice QCD calculations. The PAC is pleased to see the application of well-adapted set-ups based on successful past experiments which have been extended to accommodate the large Q^2-range.

Two proposals can be seen as a continuation of the extraordinary effort of JLab to find a definite answer to the existence of pentaquarks. With those experiments the mass and width of the θ^+ pentaquark could be determined with unprecedented accuracy. In the case of non-existence of the θ^+ pentaquark, limits on the production cross section as low as few hundred pb could be extracted. The PAC feels positive about the high precision offered by such measurements. However, at the present time the existence of the θ^+ has not been established with certainty. High statistics data should be forthcoming in the next few months from the tagged photon experiments on LH_2 and LD_2 in CLAS. In view of this, the PAC feels that it should await the outcome of those experiments in order to make a well-informed decision as to the next step in the pentaquark search program.

Four other proposals address, directly and indirectly, the question of the importance of the two-photon exchange effects in elastic electron scattering on the proton, their main motivation being to contribute to the resolution of inconsistencies between Rosenbluth separation and recoil-polarization experiments in extracting the G_E/G_M form-factor ratio for the proton. Due to increasingly theoretical interest and a continued advancement in possible experiments, some of the proposals have argued that the investigation of two-photon exchange observables should be considered as a separate goal beyond its relevance to G_E/G_M. The PAC considers it as desirable to undertake new experiments that could provide the additional (real part) information one requires to extract with high precision the underlying GEp/GMp ratio. On the other hand, given our present understanding about the full scattering amplitude, the proposals that are aimed at the imaginary parts of the two-photon contributions have implications that are less directly related to the issue of determining the ratio GEp/GMp and their impact is at present not sufficiently clear.

Another three collaborations propose to use semi-inclusive electroproduction experiments on the nucleon in a kinematical range, in which as ansatz for a theoretical description of those processes, a factorization into hard parton-level sub-processes and soft hadronic matrix elements becomes possible. Those investigations would continue recent successful recent research activities at JLab which have exploited the set-ups in Hall A and Hall C at high luminosity using polarized and unpolarized beams at the maximum beam energies. The PAC recognises the high importance of investigations into whether duality holds in semi-inclusive meson production, of determination of polarized parton distributions at large values of x and of measurements of flavor asymmetries.

A proposal with the goal to measure the helicity structure of pion photoproduction, a proposal to carry out a detailed study of the ^{4}He-nucleus with an (e,e'p)-experiment at a high momentum transfer and a proposal to check the spin transfer method by determining the form-factor ratio GEp/GMp by using a polarized beam and target complete the menu of proposals.

Recommendations

Of the sixteen proposals received, eight experiments were approved. The ratings for these eight proposals were two with A, three with A-, and three with B+. One of the proposals has been conditionally approved, subject to a further PAC review. Three experiments have been deferred with regret.

The PAC approved one experiment in Hall A for 20 days, PR-04-107, "A Detailed Study of ^{4}He Nuclei through Response Function Separations at High Momentum Transfers"..

Two experiments have been approved in Hall B for a total of 14 days: PR-04-102, Helicity Structure of Pion Photoproduction, for 9 days and PR-04-116, Beyond the Born Approximation: A Precise Comparison of Positron-Proton and Electron-Proton Elastic Scattering in CLAS, for five days. The scientific potential of PR-04-102 is seen chiefly as providing a component to a package, combined with other observables measured in E03-105, aimed at constraining the pion photo-

production amplitude through the resonance region. For PR-04-116 the five days of beam time are allocated for carrying out necessary tests to study the background and CLAS acceptance issues. If

the outcome of the beam test is positive, the experimenters are strongly encouraged to submit a new proposal to pursue this interesting physics.

The PAC approved five experiments in Hall C for a total of 140 days: PR-04-115, G0 Backward Angle Measurements, for 70 days, PR-04-101; Measurements of the Parity Violating Asymmetry in the N to Delta Transition, for zero days to run concurrently with PR-04-115; PR-04-108, an extension of GEp/GMp measurements to 9 GeV^2, for 40 days; PR-04-110, The Neutron Electric Form Factor at $Q^2 = 4.3$ $(GeV/c)^2$ from the Reaction $^2H(e,e'n)$ ^1H via Recoil Polarimetry, for 25 days; and PR-04-113, Semi-Inclusive Spin Asymmetries on the Nucleon Experiment, for 25 days.

PR-04-114, planned for Hall A, has been conditionally approved. Results of the planned in-situ background tests need to be presented before a well-founded decision about the projected statistics versus beam time can be made, and, given the timescale for this experiment, it is important to establish whether any of its goals will have been achieved by HERMES prior to the completion of this experiment.

The laboratory guidelines provided for the approval of 50 days of beam time in Hall A, 52 days of beam time in Hall B, and 135 days of beam time in Hall C. Starting with PAC 24, the formula for these guidelines has been modified, and is based on three components: 30/33/25 days of new time to be made available in Halls A/B/C, plus 100%/100%/100% of the time recovered from approved experiments now required to return to the PAC due to the jeopardy process, and 50%/50%/50% of the days under target in each hall. The PAC is allowed to exceed the laboratory guidelines if it believes the physics has sufficiently high priority, that is at a rating of A- or better, but the excess would then be deducted from the allocation of the next PAC meeting. The jeopardy process continues to evolve at JLab. At this meeting 149 days of approved time in five proposals were under jeopardy status, 20 in Hall A, 19 in Hall B and 110 in Hall C. All of these proposals but one, together 139 days, were approved. The backlog in Hall A is now about 5.2 years, while the backlog in Hall B is 4.6 years and that of Hall C, 4.5 years. The requests for beam time in Hall C at this meeting were far beyond the Hall C allocation. Given so many outstanding proposals the PAC exceeded the laboratory guidelines in that hall by 32 days.

The proposal reports and the PAC recommendations for the reviewed proposals and the response to the letters-of-intent are given in Appendices D and E. The tables on the following pages summarise the status of the JLab commitments from PAC 4-PAC26.

The PAC is very appreciative of the efforts of the Hall leaders and the Laboratory staff in support of the PAC meeting and the review process. The TAC reports have become a very important ingredient in the process of evaluation of proposals. The comments provided by the theory group are of great help by placing the proposed physics goals of the proposals in perspective with ongoing theoretical work.

The enthusiastic and thoughtful contributions of Clara Perdue, Sue Ewing, and Suzanne Roseberry were especially effective in making the PAC process proceed gracefully and with high efficiency.

Berthold H. Schoch
Chairman, Jefferson Laboratory Program Advisory Committee

Tables

Totals for PAC 4-26

	Experiments Recommended for Approval	Experiments Recommended for Conditional Approval	Totals
Experiments	155	5	160
Authors	1096	36	1132
Institutions	184	3	187
Countries	30		30

Approved Experiments Totals by Physics Topics

Topic	**Number**	**Hall A**	**Hall B**	**Hall C**
Nucleon and Meson Form Factors & Sum Rules	28	12	5	11
Few Body Nuclear Properties	29	18	6	5
Properties of Nuclei	28	7	11	10
N* and Meson Properties	48	7	31	10
Strange Quarks	22	4	15	3
TOTAL	155	48	68	39

Approved Days and Conditionally Approved Experiments

Hall	**Approved Experiments**				Conditionally Approved Experiments
	# Expts Completed (full/partial)	Days Run	No. Exps in Queue	Days to be Run	
A	30 2	546.1	20	321.8	2
B	50 7	514.6	18	266.2	2
C	22 2	521.3	16	301.2	1
Total	102 11	1582.0	54	889.2	5

APPENDICES

A. PAC 26 Membership

B. Charge to PAC 26

C. PAC 26 Recommendations

D. PAC 26 Individual Proposal Reports

E. PAC 26 Individual Letters-of-Intent Reports

F. Approved Experiments, PACs 4-26, Grouped by Physics Category

(To access Appendix F, go to http://www.JLab.org/exp_prog/PACpage/)

Appendix A
PAC 26 Membership

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Appendix B

Charge to PAC 26

Jefferson Lab requests that PAC 26:

1) Review both new proposals* and extensions† or updates‡ to previously-approved proposals, and provide advice on their scientific merit, technical feasibility and resource requirements.
2) Recommend one of four actions on each proposal, extension or update:
   - approval,
   - conditional approval status pending clarification of special issues,
   - deferral with regret,
   - deferral, or
   - rejection.

   (There are two types of conditional approval: conditional pending PAC review of open scientific questions; and conditional pending Jefferson Lab management review of open technical issues. In the later case, the PAC should recommend a beam time allocation.)
3) Provide a scientific rating and recommended beam-time allocation for all proposals recommended for approval.
4) Provide comments on letters-of-intent.
5) Comment on the Hall running schedules.

* Previously-approved proposals that have not, within 3 years of PAC approval, been scheduled to run to completion are returned to the PAC for a fresh scientific review. For the purposes of these reviews, the "jeopardy" experiments are to be treated consistently with new proposals.

† Extension proposals are treated as new proposals, and the merits and status of the original proposal are considered only to the extent that they may bear on the relevance and merit of the extension proposal.

‡ In reviewing an experiment update, the PAC will treat the original proposal and any request for changes taken together as a single new proposal and treat the combination in a manner analogous to a previously-approved proposal undergoing a jeopardy review.

APPENDIX C

PAC 26 Recommendations

Class*/Grade/Days

A/B+/*	PR-04-101	Measurement of the Parity Violating Asymmetry in the N to Delta Transition
A/B+/9	PR-04-102	"Helicity Structure of Pion Photoproduction" (update of experiment 01-104)
D	PR-04-103	Measuring the Two-Photon Exchange Amplitude with Vector Analyzing Powers in Elastic Electron-Proton Scattering
D	PR-04-104	Search for Exotic Pentaquark Θ^+ in Hall C
D	PR-04-105	Measurement of Born-Forbidden Recoil Proton Normal Polarization in Electron-proton Elastic Scattering
D/R	PR-04-106	A measurement of two-photon effects in unpolarized electron-proton scattering
A/B+/20	PR-04-107	Detailed Study of 4He Nuclei through Response Function Separations at High Momentum Transfers
A/A/40	PR-04-108	Measurement of GE_p/Gm_p to Q^2=9GeV^2 via recoil polarization
D/R	PR-04-109	Duality in Meson Electroproduction
A/A-/25	PR-04-110	"The Neutron Electric Form Factor at Q^2=4.3 (GeV/c)^2 from the Reaction ^2H(e,e'n)^ 1H via Recoil Polarimetry"
D/R	PR-04-111	Measurements of GEp/GMp using elastic polarized p(polarized e e'p) up to Q^2=5.6(GeV/c)^2
D	PR-04-112	High Resolution Search for Exotic Resonance in NK+ System near 1540 MeV
A/A-/25	PR-04-113	Semi-Inclusive Spin Asymmetries on the Nucleon Experiment
C**	PR-04-114	A Measurement of the Flavor Asymmetry Through Charged Meson Production in Semi-Inclusive Deep-Inelastic Scattering
A/A/70	PR-04-115	G0 Backward Angle Measurements
A/A-/5	PR-04-116	Beyond the Born Approximation: A Precise Comparison of Positron-Proton and Electron-Proton Elastic Scattering in CLAS

- A=Approve, C=Conditionally Approve, D=Defer, DR= Defer with Regret, R=Reject

* Run Concurrently with G0
** Conditionally Approve w/PAC Review

Appendix D

Individual Proposal Report

Proposal: PR-04-101

Scientific Rating: B^+

Title: Measurement of the Parity Violating Asymm in the N to Delta Transition

Spokespersons: S. P. Wells, N. Simicevic

Motivation: The objective of the experiment is to determine the Q^2-dependence of the axial vector transition form factor, $G^A_{N\Delta}$, by measuring the parity-violating asymmetry in single-pion electroproduction on the proton for $0.1 < Q^2 < 0.6$ $(GeV/c)^2$. The proposed measurements would represent the first determination of this quantity in the neutral current sector of the weak interaction.

Measurement and Feasibility: The experiment will run simultaneously with G0 at backward angles. The trigger of each octant will, in order to suppress the large pion background, consist of a three-fold coincidence among signals from Focal Plane Detectors, Cryostat Exit Detectors and Aerogel Cerenkov counters. Separation of the inelastic events in which a pion is produced from the elastic background will be accomplished via a fit of the response in the space spanned by CEDxFPD detector elements, constrained by the results of MC simulations. Contrary to earlier plans, the normal 499 MHz beam will be used for this backward angle experiment, making it possible to perform the experiment at a beam current of 80 μA. The PAC supports the initiatives to increase the beam current at which the beam polarization can be measured.

Issues: A newly discovered term in the weak radiative corrections for inelastic reactions leads to a non-vanishing parity violation asymmetry at $Q^2=0$. The question is to what extent this Siegert contribution has consequences for the precision with which the axial vector mass, M_A, can be determined from a fit to $G^A_{N\Delta}(Q^2)$. Data from Q_{weak} at very low Q^2 in the Δ resonance region would greatly help to constrain the fit.

Recommendation: Approve for concurrent running with G0 at backward angles.

Individual Proposal Report

Proposal: PR-04-102

Scientific Rating: B+

Title: Helicity Structure of Pion Photoproduction

Spokespersons: D. Sober, M. Khandaker, D. Crabb

Motivation: The proposed experiment would measure the circularly-polarized photon + longitudinally-polarized proton asymmetry, *E*, and its numerator the helicity dependent cross section difference, $d\sigma_{3/2} - d\sigma_{1/2}$, for exclusive π^+n, π^op and $\pi^+\pi^-p$ production up to 2.3 GeV. These photo-pion production channels have been measured at Mainz up to 0.8 GeV where deviations from multipole predictions were observed in π^op which leads to a significant modification of the helicity amplitudes of the D_{13} resonance. While similar helicity-dependent data at higher energies may well have an equally significant impact, at present only inclusive total cross section differences are available above 0.8 GeV (from Bonn).

This proposal is a jeopardy-update of E01-104, the focus of which has changed in character since PAC 20. The primary goal of PR-04-102 is now focused on providing a new constraint on multipole analyses of pion production in the baryon resonance region through direct measurements of the *E* observable.

Measurement and Feasibility: The measurements would be performed with tagged bremsstrahlung of longitudinally polarized electrons incident on a longitudinally polarized proton target centered in the CLAS. The collaboration has considerable experience and is well poised to carry out the experiment. The only non-standard equipment is the frozen-spin target which is presently under development. The planned polarizing material is butanol and the cryostat design is similar to ones built in Bonn and successfully used in the recent GDH experiments. Measurements with longitudinal target polarization are a clear initial step in the development of this target capability. It is currently anticipated that the new polarized target will be available for experiments in 2006.

Issues: The scientific potential of this proposal is seen chiefly as providing a component to a package, combined with other observables measured in E03-105, aimed at constraining the pion photo-production amplitude through the resonance region. The PAC requests that the proponents of these two experiments study the impact of the longitudinally polarized target asymmetry measurements on pion multipole decompositions with the goal of developing a balanced plan which optimizes the physics output from a coherent campaign.

Recommendation: Conditionally approve for 9 days in Hall B, subject to demonstrating to Lab Management an optimized set of measurements for the combined 18+9 = 27 days now allocated to E03-105 and E04-102.

Individual Proposal Report

Proposal: PR-04-103

Scientific Rating: N/A

Title: Measuring the Two-Photon Exchange Amplitude with Vector Analyzing Powers in Elastic Electron-Proton Scattering.

Spokespersons: S. Wells, P. King

Motivation: The vector analyzing power, or beam normal asymmetry, in elastic electron-proton scattering is zero in the one-photon-exchange approximation, but is proportional to the imaginary part of the two-photon exchange spin-flip amplitude. In the proposed Q^2 range the interpretation of this asymmetry is expressed in terms of baryon-meson degrees of freedom, and it seems to be dominated by Δ resonance contributions. Measurements of the vector analyzing power have already been performed at Mainz in this energy range at small electron-proton center-of-mass angle, and provide an initial test of theoretical calculations.

Measurement and Feasibility: The proposed experiment is aimed at measuring the vector analyzing power at three different incident electron beam energies 0.424, 0.585 and 0.799 GeV, corresponding to Q^2 values of 0.3, 0.5 and 0.8 $(GeV/c)^2$. The experiment uses the G0 detector in its backward running mode where electrons, elastically and inelastically scattered off a liquid hydrogen target, are detected. A combination of focal plane detectors and Cryostat Exit Detector paired with front-end electronics using gate arrays allows for the measurement of the scattered electron momentum. Contamination of the elastic events by inelastic events is anticipated, but will be corrected using Monte Carlo simulations to levels such that the total error on the proposed measurement is still dominated by its statistical component. To measure transverse beam polarization, an upgrade of the Moller polarimeter is required beyond the present standard G0 polarization monitor and work has already started on it.

Issues: Unlike the real part of the two-photon exchange amplitude, the imaginary part is determined using quantities accessible in inelastic scattering measurements through multipole decomposition. The proposed momentum transfers are neither large enough for an interpretation in the framework of Generalized Parton Distributions, which would have provided a clear link between the imaginary part and the real part of the two-photon exchange amplitude, nor are they low enough for a direct test of chiral perturbation calculations. Thus, the proposed measurement will not help resolve the discrepancy between the polarization transfer and the Rosenbluth determination of the ratio G_E^P / G_M^p in elastic electron-proton scattering.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-04-104

Scientific Rating: N/A

Title: Search for Exotic Pentaquark Θ^+ in Hall C

Spokespersons: H. Gao, S.N. Nakamura

Motivation: Several experiments have reported observations of the exotic baryon state denoted as the Θ^+ (1540). The observed mass values vary from 1525-1555 MeV with widths consistent with detector resolution. The proposed experiment would confirm the existence of this state, and measure the mass and width to high precision. [The search for the doubly-positive-charged pentaquark states has been dropped from the proposal as submitted.]

Measurement and Feasibility: The experiment requests 17 days of beam time in Hall C with a 25 μA beam of energy 3.475 GeV, plus 7 days of calibration and background studies. The mass and width of the Θ^+ (1540) are measured using untagged real photons from the bremsstrahlung end-point spectrum incident upon a 4 cm LD_2 target. A forward K^- is detected in the SOS spectrometer in coincidence with a K^+ in the HKS spectrometer, and a neutron in a counter which is designed but not yet built. The energy of the incident photon and the momentum vector of the spectator proton can be calculated uniquely, since the end-point energy and the energies of the detected particles ensure that no additional pions can be produced. The invariant mass of the n K^+ system is measured with a mass scale uncertainty of $\delta M = \pm 0.5$ MeV and a mass resolution of 3.1 MeV full-width-half-maximum. The forward K^- is detected in a momentum-transfer-squared range from 0.6-1.3 $(GeV/c)^2$. The HKS spectrometer and beam splitter from the E01-011 experiment and the bremsstrahlung radiator, are required for this experiment, as is the neutron detector. The HKS and neutron detector are located out of plane at angles (-32, -11) and (-23, +14) degrees, respectively, and the SOS spectrometer is positioned at +20 degrees. A prototype neutron counter has been tested, but the experiment would benefit from direct confirmation of expected background levels, accidental rates and neutron efficiency; such tests are to be performed during the requested time allocation. Direct experimental checks of mass resolution and precision of mass scale are also planned during the running period requested; these will make use of the reaction $\gamma n \rightarrow K^+\Sigma^-$ with $\Sigma^- \rightarrow \pi^- n$, and also of elastic e-p scattering. The experiment seems feasible as proposed.

Issues: The change in experimental configuration with respect to the original proposal [PR-04-004] has addressed many of the issues raised previously by the TAC. Simulation of background levels in the neutron counter has been performed, and shielding increased; in addition, the counter will now be positioned farther from the target. The readiness of the HKS and the neutron counter is essential to the experiment. The PAC feels positive about the high precision offered by such a measurement. However, at the present time the existence of the Θ^+ has not been established with certainty. High statistics data should be forthcoming in the next few months from the tagged photon experiments on LH_2 and LD_2 in CLAS. At the behest of PAC 25, an extensive effort has been undertaken to calibrate the tagger precisely, and to establish carefully the mass scale for CLAS event reconstruction. In view of this, the PAC feels that it should await the outcome of these experiments in order to make a well-informed decision as to the next step in the pentaquark search program.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-04-105

Scientific Rating: N/A

Title: Measurement of Born-Forbidden Recoil Proton Normal Polarization in Electron-proton Elastic Scattering

Spokespersons: D. Mack

Motivation: The proposal aims to measure the two-photon effects arising in electron scattering with the hope of addressing the discrepancy between G_E^p / G_M^p observed with recoil polarization vs. the Rosenbluth separation technique. Since the experiment would give information about Im (M2), it is assumed that theoretical progress will be made to connect the obtained Im (M2), to the Re(M2), which affects the extracted value of G_E^p.

Measurement and Feasibility: It is proposed to measure the normal component of recoil proton polarization P_N using a unique polarimeter. Since the one-photon exchange Born process in elastic scattering cannot produce a P_N, its observation would signal the presence of higher order processes, primarily two-photon exchange. The measurement of P_N would allow one to extract the imaginary part of the two photon amplitude Im(M2). The range of Q^2 accessed is from 0.57 to 2.1 GeV^2/c^2. The polarimeter has properties not found in the other JLab polarimeters. It consists of a solenoidal magnet rigidly positioned upstream to a conventional polarimeter. The conventional polarimeter consists of trigger and tracking spectrometers, followed by a polyethylene analyzer, further positioning scintillators, and a coaxial barrel spectrometer to provide ϕ-information, and some θ-information. The entire device would be constructed specifically on the basis of the present proposal.

Issues: While the measurement of P_N (and Im(M2)) at several values of Q^2 would be of some interest, the PAC believes that currently there are no reliable ways to connect Im (M2) to e(M2), which is necessary to address the G_E^p two-photon issue, while the realization of this proposed facility is a major resource-intensive construction and development project. The PAC believes that the TAC comments should be addressed.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-04-106

Scientific Rating: N/A

Title: A Measurement of Two-Photon Effects in Unpolarized Electron-proton Scattering

Spokespersons: John Arrington

Motivation: The proposal is aimed at a high precision measurement of elastic electron-proton scattering over a wide range of ε and Q^2. Two aspects will provide the focus of the experiment: (1) many angles will be used to make high-quality tests of the linearity of the Rosenbluth plot at Q^2 = 1.12 and 2.56 $(GeV/c)^2$, and (2) significantly improved elastic scattering cross sections will be obtained for a wide range of Q^2 extending up to about 6 $(GeV/c)^2$ with more limited reach in ε. By using these results, together with the polarization ratio from recoil polarization measurements, it is hoped that an improved understanding of the difference found between the form factor extractions performed using the Rosenbluth method and the form factor ratio determinations via polarization transfer will emerge. At present this discrepancy is attributed to two-photon contributions.

Measurement and Feasibility: The proposed measurements are based on a well-established approach and, while certainly leading to very high precision determinations of the linearity of the Rosenbluth plot, appear to be feasible. The proposal presented to this PAC is more developed and better motivated than the one reviewed by the PAC 25 and the impact of the proposed measurements on the final uncertainties in the proton form factors was clearly spelled out. A convincing case was made that these measurements are presently seen to be the only viable way to address some of the two-photon issues in elastic ep scattering at high Q^2.

Issues: Precision ε-dependence measurements at larger Q^2 than those where the proposed linearity tests would be performed would be desirable. However, due to the constraints of maximum beam energy and minimum HMS angle available, the range of ε is too limited to make linearity tests at the higher accessible Q^2.

The PAC 26 would like to see this experiment performed, but due to limitations in the available beamtime, the proposal cannot be accepted at this time.

Recommendation: Defer with regret.

Individual Proposal Report

Proposal: PR-04-107

Scientific Rating: B^+

Title: Detailed Study of ^{4}He Nuclei through Response Function Separations at High Momentum Transfers

Spokespersons: A. Saha, K. Aniol, S. Gilad, D.W. Higinbotham

Motivation: The goal of the experiment is to provide an extensive and precise set of ^{4}He (e,e'p)^{3}H data to constrain models of the short-range structure of ^{4}He and of reaction dynamics. Comparison will be made with predictions of Glauber-type calculations, relativistic mean field approaches and microscopic models, which are based on realistic interactions and currents. The high p_m results might cover the kinematical domain in which the meson-nucleon degrees of freedom are no longer appropriate.

Measurement and Feasibility: The experiment will be performed in various kinematical configurations in Hall A with the HRS magnetic spectrometers, equipped with their standard detection systems. Unpolarized beam currents of up to 75 μA will impinge on an available cryogenic target. The results will be presented as cross sections up to missing momentum, p_m=1.2 GeV/c and response functions R_{TL}, R_T and R_{L+TT} up to p_m=0.5 GeV/c. R_L and R_T will be determined at p_m=0 for q=1, 2 and 3 GeV/c. At p_m=0.4 GeV/c and in the y-scaling regime (x_B=1.86) the continuum response will be separated into its longitudinal and transverse components. In view of the results obtained in E89-044, which was performed on ^{3}He under similar kinematical conditions, the objectives of the experiment seem attainable.

Issues: Results of this experiment will, together with those of E89-044, provide a benchmark set of ^{3,4}He(e,e'p) data: the missing-momentum distributions mapped out up to p_m = 1 GeV/c and some response functions separated at p_m = 0.5 GeV/c. It is important to verify the difference between the A_{TL} response functions of ^{3}He and ^{4}He, as predicted by a relativistic mean field calculation, which hints at different roles for the lower components of the bound state wave functions and final-state interactions in the two nuclei.

Recommendation: Approve for 20 days in Hall A

Individual Proposal Report

Proposal: PR-04-108

Scientific Rating: A

Title: Measurement of G_E^p / G_M^p to $Q^2 = 9$ GeV^2 via recoil polarization

Spokespersons: C.F. Perdrisat, V. Punjabi, M. K. Jones, E. Brash

Motivation: The experiment seeks to extend the range of G_E^p / G_M^p (≡R) which was measured in experiments 93-027 and 99-007 up to $Q^2 = 5.6$ (GeV/c)^2, using the recoil polarization method. The same basic recoil polarization technique will be used in PR-04-108 (E01-109) to obtain R at three values of Q^2: 4.8, 7.5 and 9 (GeV/c)^2. The point at 4.8 (GeV/c)^2 will be used as a check of the previous results. The small difference in Q^2 from the 4.2 (GeV/c)^2 originally proposed will allow the study of the spin-transfer calculation for the HMS spectrometer. The points at 7.5 and 9 (GeV/c)^2 will extend the Q^2 range of R to the highest value obtainable with a 6 GeV beam.

Measurement and Feasibility: The new experiment will be conducted in Hall C because only the HMS spectrometer will accommodate the higher proton recoil momentum commensurate with the higher values of Q^2. In preparation for the experiment, the collaboration has been doing everything proposed for E01-109. In particular, they have nearly completed the construction of the large calorimeter *BigCal* which will be used to detect the scattered electron. Its 1744 glass panels will provide a solid angle of 115 msr, with an angular resolution of ~ 1 mr. Preliminary test results confirm its performance, with systematic cosmic calibrations expected for Fall 2004.
The work on the new focal plane polarimeter goes apace. A novelty is that it employs effectively two polarimeters in tandem, each with its own CH_2 analyzer block followed by two sets of tracking drift chambers which measure the asymmetry. Vital testing and calibration has been ongoing at the IHC in Dubna. The collaboration has obtained data showing that this double polarimeter provides up to 66 % greater efficiency than previously obtained, with essentially no degradation in analyzing power. Analyzing power measurements were also carried out up to a proton momentum of 5.3 GeV/c. Importantly, the analyzing power at 5.3 GeV is only about 30 % less than at 3.8 GeV/c. This is essential for the higher proton momenta required in the present experiment. A full-scale prototype has been constructed and delivered to JLab by IHC, which will allow important testing and calibration prior to the construction of the final version.

In summary, the PAC is impressed with the pace of preparations, and continues to support this experiment.

Issues: The physics case for the present experiment remains at least as strong as it was when E01-109 was given an A rating. The discrepancy in R between the recoil polarization and the Rosenbluth technique is of great importance and needs resolution.

Recommendation: Approve for 40 days in Hall C

Individual Proposal Report

Proposal: PR-04-109

Scientific Rating: N/A

Title: Duality in Meson Electroproduction

Spokespersons: R. Ent, H. Mkrtchyan, G. Niculescu

Motivation: The aim of the proposed experiment is to investigate whether duality holds in semi-inclusive meson production and whether factorization of that process into a hard parton-level subprocess and soft hadronic matrix elements (parton distributions and fragmentation functions) holds at kinematics accessible at JLab. If so, the ratios of the distribution functions d_v/u_v and the fragmentation functions D^-/D^+ can be extracted.

Measurement and Feasibility: The experiment proposes to measure semi-inclusive pion and kaon electroproduction at a beam energy of 6 GeV for Q^2 between 1.8 and 6.0 $(\mathrm{GeV/c})^2$ and for a large range of x and z using proton, deuteron and Al targets. Also the p_T dependence will be investigated. An aerogel detector will allow a clean pion/kaon/proton separation. The experiment has been approved by PAC18 for 20 days, but ran for 10 days only in August 2003. Preliminary data from this run exist, although only in a limited range of x and for p_T dependence at $x=0.32$ and $z=0.55$. Evidence for duality and factorization in semi-inclusive meson electroproduction is clearly seen in the preliminary data. Now the remaining 10 days are requested in order to complete the originally planned measurements.

Issues The PAC 26 would like to see this experiment performed, but due to limitations in the available beam time, the proposal cannot be accepted at this time.

Recommendation: Defer with regret.

Individual Proposal Report

Proposal: PR-04-110

Scientific Rating: A-

Title: The Neutron Electric Form Factor Q^2=4.3 $(GeV/c)^2$ from the Reaction $^2H(e,e'n)\ ^1H$ via Recoil Polarimetry

Spokespersons: R. Madey, S. Kowalski, A. Yu. Semenov, B. D. Anderson

Motivation: This is an improved version of the previous (deferred) PAC 25 proposal that intend to measure the neutron electric form factor G_E^n at 4.3 $(GeV/c)^2$ in 32 days of running in Hall C. The projected total error is equal to the one quoted for an already approved experiment at JLab, which will measure G_E^n using polarized ^{3}He to Q^2=3.4 $(GeV/c)^2$. In combination with neutron magnetic form factor data and proton form factor data, the proposed measurement would allow anisospin decomposition, and would thus provide stringent constraints on nucleon models and challenge anticipated rigorous Lattice QCD calculations. Further, with the large coincidence acceptance, the sensitivity of the measured polarization transfer on the deviation from non-quasi-free kinematics could be investigated. In addition, a check of compatibility with the polarized target technique is provided, and this may serve as a basis for future experiment planning.

Measurement and Feasibility: The proposed technique consists of quasi-free scattering of longitudinally polarized electrons from neutrons in a deuteron target, and measuring the transverse recoil neutron polarization, combined with the method of spin precession. The scattered electrons will be detected in the HMS spectrometer. The technique was implemented successfully in Hall C by the E93-038 collaboration at Q^2-values up to 1.45 $(GeV/c)^2$. With the increase in beam current and substantial expansion of the polarimeter and its shielding, the experiment appears feasible at the proposed momentum transfer of Q^2=4.3 $(GeV/c)^2$. The systematic error of the proposed measurements is estimated to be small, so that the total error would be statistics dominated. The experiment requires major installation work entailing considerable floor time.

Issues: Although the deuteron is probably the best practical neutron target, nuclear effects may still play a role in polarization observables. The PAC strongly recommends close collaboration with theory groups to maintain control over nuclear effects, especially with regard to the extension of the acceptance into the non-quasi-free region. The analyzing power for the polarimeter assumed in the simulation is based on extrapolation from measured neutron data at lower energies and proton data. Although its value cancels in the final result, it has an impact on the achievable errors. The assumed beam polarization of 80 % may be optimistic in view of the more usual 75 %.

Recommendation: Approve for 25 days in Hall C

Individual Proposal Report

Proposal: PR-04-111

Scientific Rating: N/A

Title: Measurement of G_E^p / G_M^p using Elastic Polarized Reaction *p(e*,e'p) up to Q^2= 5.6 $(GeV/c)^2$

Spokespersons: X. Zheng, J. R. Calarco, O. A, Rondon

Motivation: The determination of the proton electromagnetic form factors is of considerable physics interest, and results of high precision at the largest values of Q^2 are of great value. An experimental discrepancy was observed between the results from the Rosenbluth separation technique and those from a recoil polarization technique. The discrepancy at large Q^2 is currently attributed to the effect of two-photon exchange, neglected until recently. Theoretical calculations are presently able to account for part of the observed discrepancy. It is important to pin down the origin of this discrepancy, and confirm it, in order to yield an unambiguous extraction of the proton elastic form factors and to test the two-photon exchange calculations. The separation technique has been checked, including measurements performed at JLab. This proposal is aiming at measuring an asymmetry in a doubly-polarized experiment; this should provide a result identical to the polarization transfer data, but with very different systematic errors. In this context it would then be an important independent experimental cross-check.

Measurement and Feasibility: The experiment is proposed for Hall C and requests 23 (17+6) days of running time. This asymmetry measurement will use a polarized NH_3 target and a polarized electron beam of 5.55 GeV and of 85 nA, as allowed by the target. This is a resubmission of a proposal (PR-04-014), which was deferred by PAC 25. The new experimental scheme has been entirely revisited for this proposal; it is now a coincidence experiment, in which the scattered electron and proton are detected with specific set-ups (BETA spectrometer for the electron and a scintillator hodoscope for the proton). The choice of the spin orientation of the target as well as the detection angles of the scattered electron and proton are imposed by the design of an existing polarized target. The asymmetry measurements, providing the ratio of the electromagnetic proton form factors, will be measured at two Q^2 values (3.2 and 5.6 $(GeV/c)^2$), a range which covers completely that of the previous polarization experiment E-99-007 performed in Hall A. The experiment, with the expected precision, appears feasible although some tests of the BETA spectrometer should be performed as required by PAC24.

Issues: PAC 25 deferred PR-04-014 since the range in Q^2 covered in the measurement was not large enough and the precision it would have attained was not sufficient. This new proposal has clearly extended the Q^2 with improved precision, answering these objections. The PAC 26 would like to see this experiment performed, but due to limitations in the available beam time, the proposal cannot be accepted at this time.

Recommendation: Defer with regret

Individual Proposal Report

Proposal: PR-04-112

Scientific Rating: N/A

Title: High Resolution Search for Exotic Resonances in η K^+ System near 1540 MeV

Spokespersons: B. Wojtsekhowski, G. Cates, P. E. Reimer, V. Nelyubin

Motivation: Several experiments have reported observations of the exotic baryon state denoted as the Θ^+ (1540). The observed mass positions vary from 1525-1555 MeV with widths consistent with detector resolution. The proposed experiment would confirm the existence of this state, and measure the mass and width to high precision.

Measurement and Feasibility: The experiment requests 20 days of 5.0 GeV electron beam time in Hall A at a current of 30 μA, plus 4 days for set-up, testing and calibration studies. The mass and width of the Θ^+(1540) would be measured using a beryllium target consisting of 20 foils each of thickness 75 μm. A forward K^- would be detected in the HRSL spectrometer equipped with a septum magnet, a low-momentum K^+ would be measured in BigBite, and a neutron counter would detect the final state neutron. The invariant mass of the n-K^+ system would be measured with a mass scale uncertainty of $\delta M = \pm 0.5$ MeV and a mass resolution of 2.9 MeV full-width-half-maximum. The neutron counter is under construction, and a prototype has been tested, while commissioning of the BigBite Spectrometer is scheduled for /January, /2005. Expected background levels, accidental rates, mass resolution and precision of mass scale and resolution have been extensively checked by the proponents in the course of E-04-012, and the results are in excellent agreement with the estimates contained in the present proposal. As described, the experiment appears to be feasible.

Issues: The readiness of BigBite and the availability of the neutron counter are essential to the experiment. The PAC feels positive about the high precision offered by such a measurement. However, at the present time the existence of the Θ^+ has not been established with certainty. High statistics data should be forthcoming in the next few months from the tagged photon experiments on LH_2 and LD_2 in CLAS. At the behest of PAC 25, an extensive effort has been undertaken to calibrate the tagger precisely, and to establish precisely the mass scale for CLAS event reconstruction. In view of this, the PAC feels that it should await the outcome of these experiments in order to make a well-informed decision as to the next step in the pentaquark search program.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-04-113

Scientific Rating: A-

Title: Semi-Inclusive Spin Asymmetries on the Nucleon Experiment

Spokespersons: X. Jiang, P. Bosted, D. Day, M. Jones

Motivation: A flavor decomposition of the nucleon spin structure was recently obtained by the HERMES collaboration from a measurement of the double spin asymmetry A_{LL} in semi-inclusive deep-inelastic scattering (SIDIS) off hydrogen and deuterium targets. The goals of this proposal are to measure the polarized quark and anti-quark distributions in the regions $0.12 < x < 0.41$ and $1.21 < Q^2 < 3.14$ $(GeV/c)^2$ with a significantly improved statistical accuracy over previous experiments and to test the validity of factorization in polarized SIDIS at an electron beam energy of 6 GeV. In addition target single-spin asymmetries will be measured.

Measurement and Feasibility: The proposed measurement would use a 6 GeV polarized electron beam and longitudinally polarized NH3 and LiD targets. The scattered electrons would be detected in a large lead-glass array equipped with a gas Cherenkov counter. Charged hadrons of momentum 2.7 GeV/c would be detected and identified in coincidence. A Monte Carlo simulation of the expected background rate has been carried out and the experiment appears feasible. The kinematics of the experiment have been chosen to maximize the probability of detecting events in the current fragmentation region where factorization should apply. The semi-inclusive asymmetries can be considered within different approaches at LO and NLO levels to extract the parton distributions.

Issues: The PAC recognizes the high importance of the determination of the polarized parton distributions at large values of x. In particular the determination of the flavor asymmetry for the polarized light sea quarks will be explored with a much improved accuracy compared to that of the present data. The proposed measurement will determine whether or not this flavor asymmetry is present as in the case of unpolarized light sea quarks, as suggested by many theoretical predictions. The experiment will benefit greatly by running consecutively to the conditionally approved SANE experiment, which will use the same setup and for which experimental performances in terms of energy resolution and calibration, pion rejection and track reconstruction should be verified. For both the double- and single-spin asymmetry the proponents should carefully consider spurious asymmetries which may arise from the non isotropic azimuthal acceptance.

Recommendation: Approve for 25 days in Hall C

Individual Proposal Report

Proposal: PR-04-114

Scientific Rating: N/A (See Notes Below)

Title: A Measurement of the Flavor Asymmetry Through Charged Meson Production in Semi-Inclusive Deep-Inelastic Scattering

Spokespersons: L. Zhu, J.P. Chen, X. Jiang, J. C. Peng

Motivation: It is proposed to measure the semi-inclusive (e,e'π) and (e,e'K) reactions for both charged states on hydrogen and deuterium targets in the ranges $0.1 < x < 0.4$, $1.1 < Q^2 < 2.7$ $(GeV/c)^2$, $2.5 < W < 3.1$ GeV and $0.3 < z < 0.7$ with a 6 GeV electron beam in Hall A. Semi-inclusive deep inelastic scattering (SIDIS) provides information not accessible with inclusive deep inelastic scattering, including flavor asymmetry of the nucleon sea and fragmentation functions. Despite the physics potential offered by SIDIS, the current understanding of the mechanisms of SIDIS is still limited. It is proposed to carry out a high-statistics semi-inclusive electron scattering experiment with two major goals. First, to obtain the sea-quark asymmetry, $\bar{d}$-$\bar{u}$, and the ratio $\bar{d}/\bar{u}$ over the range $0.1 < x < 0.4$. Second to provide a measurement of the $\bar{u}/\bar{d}$ flavor asymmetry of the kaon fragmentation functions. In addition, the validity of factorization in SIDIS will be tested for charged pions and kaons.

Measurement and Feasibility: The experiment will be performed in Hall A using the BigBite spectrometer with the same detector package as the one being assembled for the Hall A G_E^n (E02-013) experiment. The Hall A HRS spectrometer will be used as the hadron arm with the septum magnet at 6^o. The recently commissioned RICH detector with a different radiator of lower refractive index will be used in combination with the standard detector package. In combination with an aerogel Cherenkov counter this will provide clean separation of $\pi^+/K^+/p$ or π^-/K^-. A threshold gas Cherenkov counter, together with lead-glass shower counters, will give excellent e/π^- separation. To reduce background the BigBite magnet will be positioned at 2.4 m from the target, allowing well-collimated shielding to be put in front. The standard 15 cm Hall A cryogenic Hydrogen and Deuterium targets will be used. The experiment may be feasible.

Issues: Confirming, or otherwise, the apparent reduction in the ratio $\bar{d}/\bar{u}$ for $x > 0.2$; determining the $(\bar{d}-\bar{u})/(u-d)$ ratio with much greater precision than is currently available; and providing additional constraints on the kaon fragmentation functions of the u and d quarks are important physics goals. The significance of the NLO corrections to the formalism should be determined. The performance (as yet unknown) of the focal plane detector of the BigBite spectrometer is a subject of concern. Results of the planned in-situ background tests need to be presented before a well-founded decision about the projected statistics versus beam time can be made. Given the timescale for this experiment it is important to establish whether any of its goals will have been achieved by HERMES prior to the completion of this experiment.

Recommendation: Conditionally Approve w/PAC Review

Individual Proposal Report

Proposal: PR-04-115

Scientific Rating: A

Title: G0 Backward Angle Measurements

Spokespersons: D. Beck

Motivation: During this phase of G0 running the detector will be moved from its current configuration at forward angles, where protons are being detected, to backward angles where electrons will be detected. Here it will be used for parity-violating (PV) electron scattering using both hydrogen and deuterium targets. The full proposal asks for three different beam energies, 799, 585 and 424 MeV, each expected to require 30 days of running for each of the two targets and thus amounting to a total of 180 days, together with a request for 10 days of commissioning time.

The goal of the experiment remains of great interest: backward-angle running on both ^{1,2}H will permit two different PV asymmetries to be extracted. In turn these two observables can then be decomposed into vector magnetic contributions (including potential effects from G_M(strange)) and axial-vector contributions (including effects from the anapole moment). Used in concert with PV studies on the proton at forward angles, both with G0 and HAPPEX in Hall A, and the World knowledge of the electromagnetic form factors of the proton and neutron, the goal is to make the best possible separation of the three new contributions to the PV asymmetry and thereby (1) to either see evidence for or set limits on the strangeness contributions to the nucleon form factors, and (2) to isolate the neutral current axial-vector form factor and thereby measure its anapole contribution. These goals remain very topical — having clear evidence for sea contributions in the nucleon form factors and making measurements of the axial-vector form factor will provide important insight into the nature of hadronic structure in the regime of non-perturbative QCD.

Measurement and Feasibility: Contrary to earlier plans, the normal 499 MHz beam is planned for this backward-angle experiment, necessitating a modification of the new electronics; it is now anticipated that 80 μA can be used. In order to suppress the large pion background, the trigger of each octant will consist of a three-fold coincidence between signals from Focal Plane Detectors, Cryostat Exit Detectors and Aerogel Cerenkov counters. The construction of the latter two is on schedule. The beam current will be increased over what could have been used with the beam structure employed in the forward-angle running. Improvements in the techniques of determining the beam polarization now make it possible to perform these calibration measurements up to 20 μA.

Issues: The separation of the elastic yield from the inelastic background (see PR-04-101) will take place via a fit of the response in the space spanned by CEDxFPD detector elements, constrained by results of MC simulations. Additionally, the contribution from the Al target walls will be measured and subtracted. It appears from the proposal that the separations can be done as required, although the final impact on the extraction of the elastic asymmetry (for this proposal) and the inelastic contributions (for PR-04-101) is not entirely clear at present.

The 10 additional days requested for commissioning appear to be warranted. Given the relatively small amount of time asked for (i.e., compared with the amount needed for forward-angle G0 commissioning), a well-thought-out strategy for using this beam time should be developed.

The proposal asks for 30 (hydrogen) + 30 (deuterium) + 10 (commissioning) for a total of 70 days. At issue is what energy to choose for the first running period. It appears that the most likely strategy will be to begin with running at 799 MeV during which experiments in the other two halls can be run at the same time, followed by a subsequent run or runs at the two lower energies where dedicated running is likely to be required.

During the PAC 26 meeting it was noted that there may not be a regular PAC meeting in six months' time and, as a consequence, the proposers of PR-04-115 submitted a letter requesting the entire 180+10 days of backward-angle G0 running.

Recommendation: The PAC recommends approval for 70 days for running in Hall C at 799 MeV. A strong case was made that, given the present choices made for beam properties, the requested beam time is appropriate, since statistical and systematic errors will be well-matched. It is anticipated that a small amount of beam time will be expended to determine the beam asymmetry. Following this, the PAC anticipates that backward-angle running of G0 will continue at lower energies. The PAC recommends that no decision be made on this phase of the total experiment: (1) one wishes to see that the forward-angle measurements have attained their stated goals before proceeding; (2) one wishes to see results from backward-angle running to be able to assess what will be required to finish the total experiment; and (3) one wishes to have the opportunity to evaluate the final phases of the experiment within the context of World measurements of the same type.

Individual Proposal Report

Proposal: PR-04-116

Scientific Rating: A-

Title: Beyond the Born Approximation:
A Precise Comparison of Positron-Proton and Electron-Proton Elastic Scattering in CLAS

Spokespersons: A. Afanasev, J. Arrington, W. K. Brooks, K. Joo, B. A. Rauc, L. B. Weinstein

Motivation: The goal of the proposed experiment is to determine the size of the two-photon exchange (TPE) effects in ep elastic scattering by measuring the ratio of elastic e^+p and e^-p scattering. The electric to magnetic proton form factor ratio, G_E/G_M, extracted by means of the conventional Rosenbluth separation method, was found to differ from that obtained by the polarization-transfer technique. While it is generally believed that TPE effects are the cause of this discrepancy, a definitive experiment to extract the TPE contribution to elastic scattering remains to be done. The proposed measurement of $\sigma(e^+p)/\sigma(e^-p)$ provides the most direct determination of the real part of the TPE amplitude, and it might resolve the discrepancy currently observed in the measurement of the proton form factors.

Measurement and Feasibility: Since a primary e^+ beam is not available at JLab, the proposed experiment will use secondary e^+/e^- beams generated at Hall B. A 1 μA 5.7 GeV electron beam incident on a 5% χ_0 radiator first produces a bremsstrahlung photon beam which subsequently interacts with a 2% χ_0 converter to generate e^+ e^- pairs. A 4-dipole chicane magnet will disperse the e^+ e^- pairs to allow the photon beam to be stopped by a photon blocker. The e^+/e^- beams will then be recombined to impinge on a single liquid hydrogen target located at the center of the CLAS. The scattered lepton and the recoil proton will be detected in coincidence. The proposed measurement of the $\sigma(e^+p)/\sigma(e^-p)$ ratio covers the kinematic regions of $0.15 < \varepsilon < 0.9$ and $0.3 < Q^2 < 3.0$ $(GeV/c)^2$. The design of the experiment contains several attractive features aimed at the reduction of systematic errors. These include the inherent symmetry in the production of the e^+ and e^- beams, the use of a single target for both beams, and the simultaneous detection of the e^-p and e^+p scattering. The ability to flip the polarities of the chicane magnetic field and the CLAS toroidal field provides useful additional checks of the systematics. Extensive Monte-Carlo simulations have been carried out to study potential background issues.

Issues: The PAC is very enthusiastic about the physics goal and the innovative approach of this proposal. However, the PAC is not convinced that the feasibility of the proposed experiment is fully demonstrated. In particular, the level of neutron background originating from the photon blocker could significantly compromise the performance of CLAS, and put severe limits on the allowable beam current. Another concern is that the inherent difference between the e^+p and e^-p acceptance for the CLAS could potentially limit the accuracy of the ε-dependence measurement. The PAC approves 5 days of beam time for carrying out necessary tests to study the background and CLAS acceptance issues. Based on the results of the beam test, the experimenters are strongly encouraged to submit a new proposal to pursue this interesting physics.

Recommendation: Approve for 5 days in Hall B

Appendix E

Individual Letter of Intent Report

Letter of Intent: LOI-04-101

Title: Determination of the θ^+ parity in the ^{9}Be (γ, K^-K^+n)^{8}Be Reaction

Contact Person: R. Hakobyan

The physics case of this letter of intent is about the θ^+ pentaquark and the ability to determine its parity, and eventually, its spin. The sign of the measured beam asymmetry in photoproduction by polarized photons incident on a neutron target should, according to certain models, determine the parity of the θ^+. The experiment should also measure the decay angular dependence of the θ^+ and hence provide information on the spin of the θ^+, although the interpretation is again model-dependent.

The experiment is proposed for Hall B with tagged linearly polarized photons produced by coherent Bremsstrahlung, and makes use of CLAS and of a Low Energy Recoil Detector (based on a Low Pressure MWPC). The reactions will take place in a solid ^{9}Be segmented target and the detection of a recoil nucleus ^{8}Be, by means of its fragmentation in two alpha particles, should be a signature of the fact that the θ^+ has been produced on a weakly bound neutron. The detection of the alphas will be performed in the low pressure (3 Torr) gas chamber, while the two kaons (K^+ and K^-) are detected with CLAS. Rate estimates have been performed, and a total rate of about 100 events of interest per day is estimated.

Although the concept is of physical interest, the PAC has raised several issues to be considered before the proposers get to the point of submitting a formal proposal. First there are concerns about the model dependence of the relationship between the sign of the beam asymmetry and the parity of the θ^+. Also more simulations are needed in particular regarding energy resolution and the impact of acceptance on the measured asymmetry. Finally the PAC suggests comparing the merit of this experimental approach with a possible use of the BONUS detector as a source of free neutrons.

Individual Letter of Intent Report

Letter of Intent: LOI-04-102

Title: A Study of Strangeness Production & Decay Processes Using A Very Forward Particle in Photo and Electro-production

Contact Person: E. Hungerford

This LOI proposes to measure non-mesonic weak decay modes of ${}_{\Lambda}^{4}H$ using the CLAS spectrometer in conjunction with a 0° electron-tagging magnetic spectrometer and a new small angle detector system (KATZ) designed for K^+ detection.

The weak decay of Λ-hypernuclei offers a unique opportunity to investigate the four-fermion weak interactions $\Lambda n \rightarrow nn$ and $\Lambda p \rightarrow np$. The ratio of these two partial decay widths, Γ_{nn}/Γ_{np}, is sensitive to the weak interaction mechanism and, in particular, to the validity of the empirical ΔI=1/2 rule found in mesonic Λ decay (Λ→πN) and kaon decays. While many mechanisms have been considered, the origin of the ΔI=1/2 rule is not completely clear. Due to the large energy released in the $\Lambda N \rightarrow NN$ decays, compared with Λ→πN decay, the ΔI=1/2 rule might be violated in these non-mesonic channels. Since bound states of Λp and Λn do not exist, the $\Lambda N \rightarrow NN$ decay widths cannot be directly measured. However, as pointed out by Dalitz, measurements of the Γ_{nn}/Γ_{np} ratios of three S-shell Λ-hypernuclei (${}_{\Lambda}^{4}H$, ${}_{\Lambda}^{4}He$, ${}_{\Lambda}^{5}He$) could provide a test of the ΔI=1/2 rule. While Γ_{nn}/Γ_{np} for ${}_{\Lambda}^{4}He$ and ${}_{\Lambda}^{5}He$ have been measured (with ~ 50% accuracy), no data exist for ${}_{\Lambda}^{4}H$, preventing a check of the ΔI=1/2 rule. The goal of this LOI is to measure Γ_{nn}/Γ_{np} for ${}_{\Lambda}^{4}H$ using the reaction ${}^{4}He\ (e,e'K^+)\ {}_{\Lambda}^{4}H$.

The PAC recognizes the interest of testing the ΔI=1/2 rule in the $\Lambda N \rightarrow NN$ decay. However, the PAC has several concerns:

1) The anticipated accuracy of 50% for the proposed measurement of Γ_{nn}/Γ_{np} for ${}_{\Lambda}^{4}H$, together with the large uncertainties of the existing data on ${}_{\Lambda}^{4}He$ and ${}_{\Lambda}^{5}He$, prevent a meaningful test of the ΔI=1/2 rule.

2) A significant test of the ΔI=1/2 rule in the $\Lambda N \rightarrow NN$ decays require accurate Γ_{nn}/Γ_{np} data on all three hypernuclei (${}_{\Lambda}^{4}H$, ${}_{\Lambda}^{4}He$, ${}_{\Lambda}^{5}He$). However, the proposed technique only applies to ${}_{\Lambda}^{4}H$.

3) It is not clear that the proposed measurement requires CLAS. A detector array capable of measuring neutrons and protons appears better suited for detecting the $\Lambda N \rightarrow NN$ reaction.

This LOI also describes the design of a small angle detector system (KATZ) which would increase the forward and backward angle coverage of CLAS. However, it is not clear that the proposed design has been optimized for use as a general purpose detector to augment the CLAS. While such a detector upgrade is of potential interest, clear physics justification remains to be identified.

The Individual Letter of Intent Report

Letter of Intent: LOI-04-103

Title: A Search for Bound θ^+ Nuclei in Hall A

Contact Person: R. Feuerbach

The intent is to look for a bound state of the θ^+ in nuclei by means of the reaction γ A $\rightarrow$ K^- A' and use this to determine the parity of the θ^+. The experiment is proposed in Hall A using the septum magnets to select small momentum transfers at very small angles, allowing a large ϕ coverage. The spectrometers will be used to detect electrons and K^- in order to determine the missing mass. The experiment will require high luminosity (10^{38} cm^{-2} s^{-1}) and will use a ^{12}C target. Rates estimates are given but are based on several key assumptions, in particular the photoproduction cross section and the sticking probability.

The motivation for the proposal comes from a model calculation by Miller. In the naïve quark model the mass of the θ^+ is far below expectation and it is conjectured that this is due to a large residual interaction which lowers the mass of the θ^+ to the experimentally observed value. It is then assumed that this must come from collective effects and a schematic interaction is introduced that allows the θ^+ to be described as a coherent set of color-singlet pseudoscalar excitations that move in a p-wave relative to the nucleon, presuming that the θ^+ has even parity. The model accounts for the mass and narrow width of the θ^+ and predicts a strong K* interaction and, most dramatically, a strong attractive interaction between the θ^+ and the nucleon. This is sufficient to bind the θ^+ to a nucleus in a state that is stable against decay via the strong interaction. This is not the case if the parity of the θ^+ is odd.

The possibility of bound states of the θ^+ in nuclei is potentially very interesting. However the model on which this LOI is based is speculative and, even if qualitatively sound, the quantitative results have to be treated with some caution. Further uncertainties are the forward photoproduction cross section used and the sticking factor, as calculating that for a strongly bound θ^+ is rather different from that for a lightly bound Λ. A lot of theoretical work has to be done before a proposal can be submitted. The experimental details are very sketchy and many aspects need to be investigated in detail. The fraction of kaons in the spectrometer and background rates are of particular relevance. The PAC would be interested in seeing a more detailed LOI with more robust theoretical and experimental information.

Individual Letter of Intent Report

Letter of Intent: LOI-04-104

Title: Measurement of the Target Single-Spin Asymmetry in Quasi-Elastic $^3He^{\uparrow}$ (e,e')

Contact Person: T. Averett

This letter of intent proposes to measure the target spin asymmetry A_y for the neutron using quasi-elastic scattering off a transversely polarized ^{3}He target. Two HRS spectrometers will be placed symmetrically on each side of the beam to detect the scattered electrons and to test the requirement $A_y(\theta_e) = -A_y(-\theta_e)$. The measurement will need a further investigation of how one makes an accurate determination of the relative luminosities of the two polarization directions. In order to extract the asymmetry for the neutron, the effects of the ^{3}He elastic and the nucleon inelastic contributions may be large and will have to be considered very carefully.

The PAC is concerned that the A_y measurement, while a clean way to probe the imaginary part of the two-photon exchange, is not directly relevant for resolving the G_E/G_M discrepancy, which is only sensitive to the real part of the two-photon amplitude. In addition, the limited accuracy and the restricted Q^2 range of the measurement will not provide strong constraints to GPD models which are used to predict the size of A_y.

Appendix F

Jefferson Lab Experiments, PAC 4-26, Grouped by Category

(To access Appendix F, go to http://www.JLab.org/exp_prog/PACpage/)